

What is claimed is:

1. A method for fabricating a semiconductor device,
comprising the steps of:
 - 5 forming a hard mask insulation layer on an etch target
layer;
 - forming a hard mask sacrificial layer on the hard mask
insulation layer;
 - coating a photoresist on the hard mask insulation
10 layer;
 - selectively performing a photo-exposure process and a
developing process to form a photoresist pattern having a
first width for forming a line pattern;
 - selectively etching the hard mask sacrificial layer by
15 using the photoresist pattern as an etch mask to form a
sacrificial hard mask having a second width;
 - removing the photoresist pattern;
 - etching the hard mask insulation layer by controlling
excessive etching conditions with use of the sacrificial
20 hard mask as an etch mask to form a hard mask having a
third width; and
 - etching the etch target layer by using the sacrificial
hard mask and the hard mask as an etch mask to form the
line pattern having a fourth width,
 - 25 wherein the first width is wider than the fourth width.

2. The method as recited in claim 1, wherein the etch

target layer is a conductive layer and the line pattern is one of a bit line, a word line and a metal line.

3. The method as recited in claim 1, wherein the
5 photoresist is one of a photoresist for use in ArF photolithography and a photoresist for use in F₂ photolithography.

4. The method as recited in claim 1, wherein
10 magnitudes of the first width to the fourth width are in a descending order of the first width, the second width, the third width and the fourth width.

5. The method as recited in claim 1, wherein the
15 first width is wider than the fourth width by about at least 20 nm.

6. The method as recited in claim 1, wherein the
20 sacrificial hard mask is removed at the step of removing the etch target layer.

7. The method as recited in claim 1, wherein the hard
mask sacrificial layer is made of a material selected from
a group consisting of polysilicon, aluminum (Al), tungsten
25 (W), tungsten silicide (WSi_x), where x ranges from about 1 to about 2, tungsten nitride (WN), titanium (Ti), titanium nitride (TiN), titanium silicide (Tisi_x), where x ranges

from about 1 to 2, titanium aluminum nitride (TiAlN), titanium silicide nitride (TiSiN), platinum (Pt), iridium (Ir), iridium oxide (IrO₂), ruthenium (Ru), ruthenium oxide (RuO₂), silver (Ag), cobalt (Co), gold (Au), tantalum
5 nitride (TaN), chromium nitride (CrN), cobalt nitride (CoN), molybdenum nitride (MoN), molybdenum silicide (MoSi_x), where x ranges from about 1 to about 2, aluminum oxide (Al₂O₃), aluminum nitride (AlN), Platinum silicide (PtSi_x), where x ranges from about 1 to about 2 and chromium
10 silicide (CrSi_x), where x ranges from about 1 to 2.

8. The method as recited in claim 7, wherein the etch target layer is made of the same material used for the hard mask sacrificial layer.

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9. The method as recited in claim 1, wherein the hard mask sacrificial layer is made of one of an oxide-based material, a nitride-based material and an oxynitride based material.

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10. The method as recited in claim 2, wherein the etch target layer is preferably made of tungsten.

11. The method as recited in claim 7, wherein at the
25 step of etching the hard mask sacrificial layer, a plasma containing a mixed gas of sulfur hexafluoride (SF₆) and nitrogen (N₂) is used if the hard mask sacrificial layer is

made of tungsten.

12. The method as recited in claim 11, wherein at the step of etching the hard mask sacrificial layer made of tungsten, bottom and top portions of a reaction chamber of a reactive ion etching (RIE) equipment are supplied with different powers ranging from about 450 Watt to about 850 Watt and from about 30 Watt to about 60 Watt, respectively along with a chamber pressure maintained in a range from about 8 mTorr to about 16 mTorr and a mixed gas of SF₆ and N₂ each with a quantity in a range from about 7 sccm to about 13 sccm and from about 10 sccm to about 20 sccm, respectively.

13. The method as recited in claim 7, wherein at the step of etching the hard mask sacrificial layer, a chlorine-based gas is used as a main etch gas if the hard mask sacrificial layer is formed with one material of polysilicon and Ti and one of oxygen (O₂) gas and carbon fluoride (CF) gas is added to the main etch gas to control an etch profile.

14. The method as recited in claim 7, wherein at the step of etching the hard mask sacrificial layer, one of a chlorine-based plasma and a fluorine-based plasma is used if the hard mask sacrificial layer is made of a material selected from a group consisting of Pt, Ir, Ru and any one

oxide of these listed metals.

15. The method as recited in claim 9, wherein at the step of etching the hard mask insulation layer, a plasma
5 containing a mixed gas of carbon tetrafluoride (CF₄), trifluoro methane (CHF₃), ethylene (C₂H₄), helium (He), argon (Ar) and oxygen (O₂) is used if the hard mask insulation layer is made of a nitride-based material.

10 16. The method as recited in claim 14, wherein at the step of etching the nitride-based hard mask insulation layer, a RIE equipment is used by supplying a power in a range from about 400 Watt to about 800 Watt along with a pressure maintained in a range from about 35 mTorr to about
15 65 mTorr and a mixed gas of CF₄, CHF₃, Ar and O₂ each with a quantity in a range from about 25 sccm to about 65 sccm, from about 40 sccm to about 80 sccm, from about 50 sccm to about 100 sccm and from about 12 sccm to about 25 sccm, respectively.

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17. The method as recited in claim 1, wherein the step of etching the etch target layer proceeds by using a plasma containing a mixed gas of SF₆ and N₂.

25 18. A method for fabricating a semiconductor device, comprising the steps of:

forming a hard mask insulation layer on an etch

target layer;
forming a hard mask sacrificial layer on the hard
mask insulation layer;
forming an anti-reflective coating layer on the hard
5 mask sacrificial layer;
coating a photoresist on the anti-reflective coating
layer;
selectively performing a photo-exposure process and a
developing process to form a photoresist pattern having a
10 first width for forming a line pattern;
etching the anti-reflective coating layer by using
the photoresist pattern as an etch mask;
selectively etching the hard mask sacrificial layer
with use of the photoresist pattern as an etch mask to form
15 a sacrificial hard mask having a second width;
removing the photoresist pattern and the anti-
reflective coating layer;
etching the hard mask insulation layer by controlling
excessive etching conditions with use of the sacrificial
20 hard mask as an etch mask to form a hard mask having a
third width; and
etching the etch target layer by using the sacrificial
hard mask and the hard mask as an etch mask to form the
line pattern having a fourth width,
25 wherein the first width is wider than the fourth
width.

19. The method as recited in claim 18, wherein the photoresist is one of a photoresist for use in ArF photolithography and a photoresist for use in F₂ photolithography.

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20. The method as recited in claim 18, wherein magnitudes of the first width to the fourth width are in a descending order of the first width, the second width, the third width and the fourth width.

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21. The method as recited in claim 18, wherein the first width is wider than the fourth width by at least about 20 nm.

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22. The method as recited in claim 18, wherein the hard mask sacrificial layer is made of a material selected from a group consisting of polysilicon, Al, W, WSi_x, where x ranges from about 1 to about 2, WN, Ti, TiN, TiSi_x, where x ranges from about 1 to 2, TiAlN, TiSiN, Pt, Ir, IrO₂, Ru, RuO₂, Ag, Co, Au, TaN, CrN, CoN, MoN, MoSi_x, where x ranges from about 1 to about 2, Al₂O₃, AlN, PtSi_x, where x ranges from about 1 to about 2 and CrSi_x, where x ranges from about 1 to 2.

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23. The method as recited in claim 18, wherein the anti-reflective coating layer is made of an organic material.

24. The method as recited in claim 20, wherein the step of etching the anti-reflective coating layer proceeds by using a plasma containing a mixed gas of Cl₂ and Ar.

5 25. The method as recited in claim 24, wherein at the step of etching the anti-reflective coating layer, bottom and top portions of a reaction chamber of a RIE equipment are supplied with different powers ranging from about 400 Watt to about 800 Watt and from about 70 Watt to about 130
10 Watt, respectively along with a chamber pressure maintained in a range from about 6 mTorr to about 12 mTorr and a mixed gas of Cl₂ and Ar each with a quantity in a range from about 35 sccm to about 65 sccm and from about 20 sccm to about 50 sccm, respectively.

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26. A method for fabricating a semiconductor device, comprising the steps of:

forming a conductive layer containing tungsten on a substrate;

20 forming a hard mask insulation layer on the conductive layer;

forming a hard mask sacrificial layer containing tungsten on the hard mask insulation layer;

25 forming a photoresist pattern having a first width on the hard mask sacrificial layer;

selectively etching the hard mask sacrificial layer with use of the photoresist pattern as an etch mask to form

a sacrificial hard mask having a second with;

removing the photoresist pattern;

etching the hard mask insulation layer with use of
the sacrificial hard mask as an etch mask by controlling
5 excessive etching conditions to thereby form a hard mask
having a third width; and

etching the conductive layer by using the sacrificial
hard mask and the hard mask as an etch mask to form the
line type conductive pattern having a fourth width,

10 wherein the first width is wider than the fourth
width.

27. The method as recited in claim 27, wherein the
photoresist pattern is one of a photoresist for use in ArF
15 photolithography or a photoresist for use in F₂
photolithography.

28. The method as recited in claim 26, wherein the
conductive pattern is one of a bit line, a word line and a
20 metal line.

29. The method as recited in claim 26, wherein
magnitudes of the first width to the fourth width are in a
descending order of the first width, the second width, the
25 third width and the fourth width.

30. The method as recited in claim 26, wherein the

sacrificial hard mask is removed at the step of etching the conductive layer.

31. The method as recited in claim 26, wherein the
5 conductive layer is made of the same material with the hard mask sacrificial layer.

32. The method as recited in claim 26, wherein the
conductive layer and the hard mask sacrificial layer both
10 containing tungsten include any one of a W layer, a WSi_x layer and WN layer.

33. The method as recited in claim 26, wherein the
hard mask insulation layer is formed with one of an oxide-
15 based material, a nitride-based material and an oxynitride-based material.

34. The method as recited in claim 26, wherein an
anti-reflective coating layer is formed on between the hard
20 mask insulation layer and the hard mask sacrificial layer.

35. The method as recited in claim 26, wherein the
step of etching the hard mask sacrificial layer proceeds at
a RIE equipment by using a plasma containing a mixed gas of
25 SF_6 and N_2 and top and bottom portions of a reaction chamber
of the RIE equipment are supplied with different powers
ranging from about 450 Watt to about 850 Watt and from

about 30 Watt to about 60 Watt, respectively along with a pressure maintained in a range from about 8 mTorr to about 16 mTorr, SF₆ with a quantity ranging from about 7 sccm to about 13 sccm and N₂ with a quantity ranging from about 10
5 sccm to about 20 sccm.